Resource and Admission Control in NGN

Abstract:
After the separation of service control from transport function in the Next Generation Network (NGN), a concept of the Resource and Admission Control (RAC) was introduced to ensure the Quality of Service (QoS). It hides the details of transport network to the service layer to support the separation of service control from transport function. It detects the resource status of transport network to secure a correct and reasonable usage of transport network resources. This accordingly ensures there are sufficient resources available to guarentee the appropriate level of QoS and avoid bandwidth and service stealing. The functional architecture, the entity involved and reference point, the access type and terminal, the resource control mode, the selection mechanism between functional entities, the interconnection between different domains, and the interaction between other transport control functions are the core study content of RAC. The RACS of the Telecoms & Internet Converged Services & Protocols for Advanced Networks (TISPAN) and the Resource and Admission Control Function (RACF) of the International Telecommunication Union Telecommunication Standardization Sector (ITU-T) differ in research focus. Consequently, the unification of Architecture, defined by different organizations, becomes the central issue of future research for each organization.

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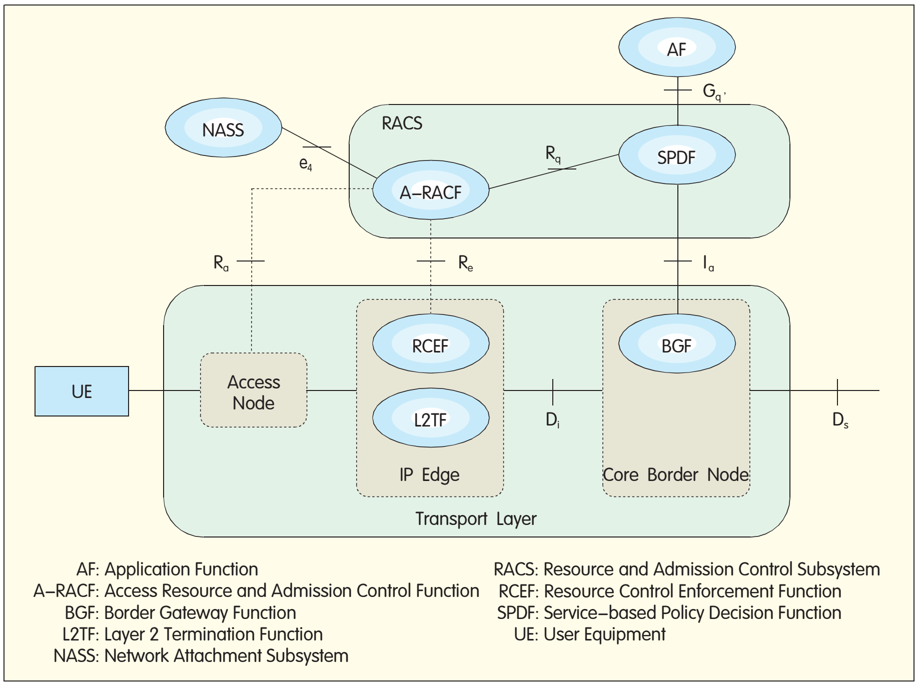
The Resource Admission Control (RAC) is a brand-new concept introduced into the Next Generation Network (NGN). It resides between the service control layer and the bearer transport layer. It hides the details of transport network to the service layer to support the separation of service control from transport function. It detects the resource status of transport network to secure a correct and reasonable usage of transport network resources. This accordingly ensures there are sufficient resources available to guarentee the appropriate level of Quality of Service (QoS) and avoid bandwidth and service stealing.

The research on RAC has been a hot subject for standardization organizations home and abroad. The International Telecommunication Union Telecommunication Standardization Sector (ITU-T), the Telecommunications and Internet Converged Services & Protocols for Advanced Networks (TISPAN), the Third Generation Partnership Project (3GPP), 3GPP2, and the China Communications Standards Association (CCSA) have been in research on RAC to various extents.

There are differences between titles given to RAC by different organizations. The same is true for the functional architecture and the research scope of them. The RAC was initially and clearly put forward in TISPAN. The function concerned was named as RACS. Specifications for Phase R1, *ETSI ES 282 003 v1.6.8* has been released. The ITU-T titled the function as Resource and Admission Control Function (RACF). The research started in June 2004 and it was carried out by the Focus Group on Next Generation Networks (FGNGN). After the FGNGN reached the end of work in November 2005, relevant assignment has been continued by other research groups of ITU-T. ITU-T SG13 is mainly focused on Functional Architecture of RACF. Draft Y.RACF for Phase R1 has been passed in the meeting held in July 2006. The SG11 is specialized in interfaces and protocols between physical entities involved with RACF. Seven drafts on specifications for five interfaces have been made ready. Another two specifications have been directed into plan. In 3GPP, the function concerned with RAC named as the Policy and Charging Control (PCC). Specification for 3GPP R7, *3GPP TS 23.203 v1.0.0* has been released.

The research status of China on RACF is basically in the same pace with that of ITU and TISPAN. *Carrier-class IP QoS Architecture* and three other



▲Figure 1. The functional architecture of TISPAN RACS R1.

technical reports on the interface protocol were passed respectively in WG1 Meeting No. 13 and WG2 Meeting No. 7 held in March 2006. Part of the research result has been submitted in technical document to the study groups of TISPAN and ITU-T.

1 Functional Architecture and Entity

1.1 Functional Architecture of TISPAN RACS

The functional architecture of TISPAN RACS R1 is illustrated in Figure 1[1]. RACS consists of two types of entities: the Service-based Policy Decision Function (SPDF) and the Access Resource and Admission Control Function (A-RACF).

The SPDF provides the application layer with a single point of contact, hides the topology of bottom network and specific access type, and supplies service-based policy control. In addition, SPDF selects local policy according to request from the Application Function (AF), maps the request into IP QoS parameters, and sends them to A-RACF and the Border Gateway Function (BGF) to request for corresponding resources.

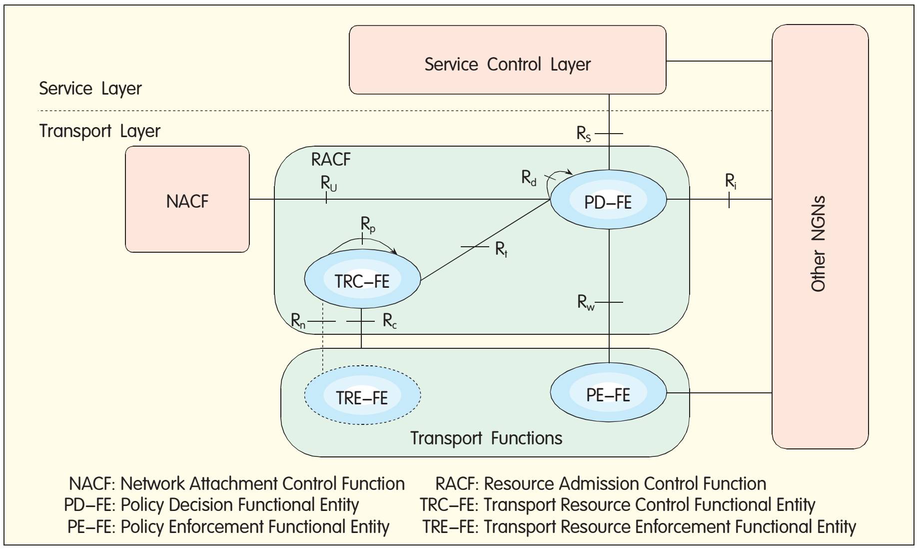
Residing in the Access Network (AN), the A-RACF has the admission control and the network policy convergence functions. It receives request from SPDF. Based on the stored policies, admission control is realized by accepting or refusing the request for transport resources. The A-RACF obtains the network attachment and subscriber QoS list information from the Network Attachment Subsystem (NASS) via e_4 reference point. Accordingly, available network resources can be assured with the network location information (as the physical node address of the access subscriber). Meanwhile, the subscriber QoS list information is referred to in the process of resource request.

The transport layer consists of three types of Functional Entities (FEs). Among them, BGF is a packet-to-packet gateway. It can be located between AN and the Core Network (CN) . It can also be located between two CNs. Under the control of SPDF, BGF completes the Network Address Translation (NAT), gate, QoS label, bandwidth restriction, measurement and resource synchronization functions. The Resource Control Enforcement Function (RCEF) practices the media stream policy of Layer 2/Layer 3 (L2/L3) sent through the R_e reference point by A-RACF to accomplish gate, QoS label, bandwidth restriction and other functions. The Layer 2 Termination Function (L2TF) is the FE terminating the Layer 2 connection in AN. The RCEF and L2TF are different FEs. They are usually realized together on the IP Edge physical equipment. In phase R1, no research work was carried out over the access node.

1.2 Functional Architecture of ITU-T RACF

The functional architecture of ITU-T RACF is illustrated in Figure 2[2].

The Policy Decision Functional Entity (PD-FE) consists of transport technology-independent resource



▲Figure 2. The functional architecture of ITUT-T RACF.

control functions and is independent of the service control function SCF as well. It makes the final decision regarding network resource and admission control based on the network policy rules, the service information provided by SCF, transport subscription information provided by the Network Attachment Control Function (NACF) in access networks, and the resource-based admission decision results supplied by the Transport Resource Control Functional Entity (TRC-FE). The PD-FE controls the gates in the Policy Enforcement Functional Entity (PE-FE) at a per flow level and applies the policy rules based on the service.

The TRC-FE is service-independent and consists of transport technology-dependent resource control functions. It is responsible for collection and maintenance of the transport network topology and resource status information. Based on topology, connectivity, availability of network and node resources, transport subscription information in access networks , and other network information, the TRC-FE authorize resource admission control of the transport network. Through the R_t reference point, PD-FE requests TRC-FE to detect or decide the QoS resources on the media stream path requested.

The transport layer consists of PE-FE and the Transport Resource Enforcement Functional Entity (TRE-FE). The PE-FE is a packet-to-packet gateway, which can be located between the Customer Premise Equipment (CPE) and AN, AN and CN, or different operators' networks. It is a key node to support the QoS control, the Network Address Port Translation (NAPT) control and the NAT Traversal (NAT-T). The TRE-FE enforces transport resource policy rules instructed by TRC-FE. Its scope, function, and R_n reference point is expected to be studied further. They are beyond the research scope of phase R1.

2 Comparison between TISPAN RACS and ITU-T RACF

2.1 Functional Entity and Reference Point

In terms of function, PD-FE is similar to

▼Table 1. Corresponding relations of reference points involved in RACF and RACS

ITU-T RACF	TISPAN RACS
R_s (between SCF and PD-FE)	$G_{q'}$ (between AF and SPDF)
R_t (between PD-FE and TRC-FE)	R_q (between SPDF and A-RACF)
R_w (between PD-FE and PE-FE)	I_a (between SPDF and BGF)+Re (between A-RACF and RCEF)
R_c (between TRC-FE and Transport Layer)	/
R_u (between NACF and PD-FE)	e_4 (between NASS and A-RACF)
R_n (between TRC-FE and TRE-FE)	R_a
R_i (between PD-FE of different operators)	/
R_d (between PD-FE of the same operator)	/
R_p (between TRC-FE of the same operator)	/

AF: Application Function
A-RACF: Access Resource Admission Control Function
NACF: Network Attachment Control Function
NASS: Network Attachment Subsystem
RACF: Resource Admission Control Function
RACS: Resource and Admission Control Subsystem
RCEF: Resource Control Enforcement Function
PD-FE: Policy Decision Functional Entity
PE-FE: Policy Enforcement Functional Entity
SCF: Service Control Function
SPDF: Service-based Policy Decision Function
TRC-FE: Transport Resource Control Functional Entity
TRE-FE: Transport Resource Enforcement Functional Entity

SPDF, while SPDF includes part of TRC-FE functions, such as to collect the resource status of the transport layer. The TRC-FE and the A-RACF are in correspondence, but not completely. The TRC-FE which can be located both in AN and CN, has more flexible position than A-RACF, which is only a function of AN. Based on different locations in network, the PE-FE is respectively in correspondence with the Core Border Gateway Function (C-BGF), the Interconnect Border Gateway Function (I-BGF) and the Resource Control Enforcement Function (RCEF)[3].

Due to differences in the function definition, there are differences in reference points accordingly. As PD-FE in RACF architecture may be needed to push to PE-FE such network information as the physical link identifier and the logic link identifier, which needs to be received from NACF, the connection point between RACF and NACF shall therefore be PD-FE. However, in TISPAN architecture the connection point between RACS and NASS is A-RACF[4].

The ITU-T RACF architecture considers the whole QoS control of AN, CN and external networks, while the TISPAN RACS architecture in phase R1 deals with the control over AN only. No definition was worked out for IP CN, external networks, and more. For this reason, comparing to RACS, new reference points were added to RACF, including R_d, R_i and R_p reference points. Corresponding relations of reference points involved in the RACF architecture and the RACS architecture are listed in Table 1.

2.2 Type of Access Network and CPE

The RACF defines three different kinds of Customer Premises Equipment (CPE). The first category is the CPE without QoS negotiation capability, which cannot directly request for QoS resource at service request. The second category is CPE with the service layer QoS negotiation capability, e.g., SIP phone with SDP /SIP QoS extensions, which can perform the QoS negotiation through the service layer signaling. The third category is CPE with the transport layer QoS negotiation capability, e.g., the Universal Mobile Telecommunications System (UMTS) terminal. It supports the Resource Reservation Protocol (RSVP) or other transport layer signaling, such as PDP context and ATMPNNI/Q.931. Through transport equipment as the Asymmetrical Digital Subscriber Line Access Multiplexer (ADSLAM), the Service General Packet Radio Service Support Node/Gate General Packet Radio Service Support Node (SGSN/GGSN), it performs the transport layer QoS negotiation directly. The CPE in RACF therefore considers mobile terminal. Presently TISPAN RACS only considers such AN as the Digital Subscriber Line (xDSL). The CPE type includes the first and the second categories mentioned.

2.3 Resource Control Mode

The RACF supports two modes of QoS resource control as "pull" and "push" to adapt itself to different types of CPE[5].

In the Pull mode, the RACF makes the authorization decision based on policy rules, and, upon the request of the transport functions, re-authorizes the resource request and responds with the final policy decision for enforcement. This is suitable for the third category of CPE with transport layer QoS negotiation capability. The transport layer QoS signaling can be applied to request explicitly for QoS resource reservation.

In the Push mode, the RACF makes the authorization and resource control decision based on policy rules and autonomously instructs the transport functions to enforce the policy decision. This mode is suitable for the first and second categories of CPE. For the first category, SCF decides on QoS request in place of CPE. For the second category, SCF is to extract QoS request from the application layer signaling.

The RACS presently supports the push mode only.

2.4 Selection Mechanism

In order to transfer the resource control request between relevant FEs, a FE shall first select a communication party. The RACF defines two types of mechanism: static mechanism and dynamic mechanism[5]. In the static mechanism, a FE may identify the target communicating party (e.g., SCF to PD-FE, PD-FE to PE-FE, PD-FE to TRC-FE) through statically configured location information, which includes either the IP address or the Fully Qualified Domain Name (FQDN). In the dynamic mechanism, a FE may identify the target communicating party and determine its network address automatically through information such as the type of service and a set of service attributes, or the query of the DNS using the end user's identifier RACF is presently required to support the static mechanism compulsively , and that of the dynamic mechanism optionally.

In RACS, AF is able to obtain IP address or domain name of SPDF through the interface with NASS or local configuration information , and SPDF obtains A-RACF and BGF Address through local configuration.

2.5 Networking and Interconnection

ITU-T considered two networking modes to achieve End-to-End QoS after the introduction of RACF[6]. In the case when AN and CN are in separate administrative domains, one approach is that the application layer SCF serves to accomplish QoS negotiation between different operators. The SCF communicates with and controls both PD-FEs in access and core networks via R_s reference points. There is no information exchange between the two PD-FEs in the access and core networks. It is also possible to complete QoS negotiation at the RACF level. There is no information exchange between the SCF and PD-FEs in the AN, and SCF communicates with the PD-FE only via the PD-FE in CN. The PD-FEs in AN and CN communicate via the R_i reference point. The networking mode is also applicable for interconnection between CN of different operators.

It is under the assumption of a guaranteed QoS for CN that TISPAN takes solution to QoS of AN as research focus. Consequently, the realization of an end-to-end QoS is not covered. The C-BGF interconnects between CN and AN, and the I-BGF between CNs.

2.6 Interacting with NACF/NASS

The information description on interaction of ITU-T RACF with NACF is not distinct. However, TISPAN definitely specified how the A-RACF to relate the information from NASS and SPDF and complete RAC accordingly.

3 Further Research Focus

The TISPAN started its research on RACS earlier than ITU-T did on RACF, but ITU-T RACF demonstrates a more comprehensive scope in research. Accordingly, the unification of architectures defined by different organizations shall become a research focus for all organizations.

The research content brought forward in TISPAN RACS R2 includes the perfection of a coherent functional architecture with ITU-T and 3GPP, the support of a practical scenario with multi-domain and multi-operator, the support of other access modes apart from the fixed bandwidth access in NGN, the realization of information exchange between NASS and SPDF, the support of end-to-end QoS, and more.

In ITU-T RACF, issues expected to be further studied include the perfection of coherence between resource control architecture defined by TISPAN, 3GPP and 3GPP2, the unification of network QoS information transmitted through the R_i reference point between different operators, the realization of end-to-end signaling flow, the completion of functional location for TRE-FE, the definition for the R_n reference point between TRC-FE and TRE-FE, the support of online charging, the interaction with NASF, and more.

References

[1] ETSI ES 282 003 V1.6.8 Telecommunications and Internet Converged Services and Protocols for Advanced Networking (TISPAN), Resource and Admission Control Subsystem (RACS) functional architecture[S].

[2] ITU-T Draft Recommendation Y.RACF Version 9.2 Functional architecture and requirements for resource and admission control functions in next generation networks[S].

[3] ITU-T Kobe-Q04-13-014 Comparison of TISPAN RACF and ITU-T RACF[S].

[4] ITU-T Kobe-Q04-13-007 Proposed modifications to Ru reference point and RACF architecture[S].

[5] ETSI TISPAN 10bTD107 Current technical analysis of RACF and RACS[S].

[6] ETSI TISPAN 10tTD069 Comparison of some issues of RACS-RACF-PCC architectures[S].

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